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Complexity

We can characterise music that is rich, varied, and multi-layered in terms of musical elements and structure such as pitch, rhythm, harmony, and timbre as complex. For this reason, complexity is determined by separate elements of music (e.g. rhythm, harmony, melody, and structure) but also the meanings linked with music due to lyrics, memories, and cultural associations.

We can also relate complexity to a myriad of issues such as culture, cognitive processing, and musical preferences. It is one of the characteristics of music across different cultures and eras and often associated with stylistic and compositional development and in the 1990s, and it even gave its name to a compositional movement (New Complexity).

In behavioural sciences, we associate complexity in music with increased cognitive processing, which in turn, has consequences for musical behaviour. According to the notion of optimal complexity – proposed by Wilhelm Wundt in the 19th century and popularized by Daniel Berlyne in the 20th century – a curvilinear relationship exists between stimulus complexity and preference. In music, the most preferred music is of medium complexity, as simple and complex music fails to arouse listeners in an optimal fashion. Due to this connection, one can utilise complexity as a variable in research into music, such as the influence of music on driving, waiting time, or even as a predictor to chart success. The notion receives empirical support in music, although the exact configuration of complexity and its connection to preferences is elusive.

From number theories to information-theoretic estimations of complexity

During the renaissance period and up until the 18th century, we associated complexity in music with number theories originating from the Pythagorean tradition (harmonic ratios that vary from simple to complex). In the mid-20th century, information theory provided the formal means of defining complexity in music, where we measure the amount of information carried by the discrete elements of the music in bits. This measure originated from Claude Shannon's concept of entropy that determines the uncertainty of a signal. Another way to define complexity is to describe the absolute amount of information that is required to transmit the object, known as Kolmogorov complexity.

From the 1970’s to 1990’s, one typically applied the information theoretic calculation of complexity to melodies (pitches, intervals, or durations) and these predictions have been broadly similar to complexity ratings provided by listeners. These studies have also found support for the fractal-like qualities (1/f) of music, in which the frequency spectrum of discrete items is optimally complex for a particular region of the slope (between 1-2 in speech and music) describing the spectrum (Beauvois, 2007).

The problem with information-theoretic notions is that the probabilities of notes and durations are far from uniform since statistical regularities for each property exists in music. For this reason, after the 1980s, in Western music, estimates of complexity took into account the probabilities of tones and intervals. For example, Dean Keith Simonton calculated the transition probabilities of a glossary of over 15 000 classical music themes and used this information to define the originality (close variant of complexity) of the individual themes. Interestingly, this measure of complexity was found to be associated with biographical and historical trends.

Perceptual complexity of music

The main problem with all objective formulations of complexity is that they do not incorporate human processing of the music. Therefore, another line of research has assumed that they can establish only relative complexity for a particular cultural group. In this approach, scholars have subjected a wide range of music to an empirical rating experiment and connected the musical complexity both to stimulus properties and to the learning and processing of these properties (Eerola et al., 2006). The models incorporate the known regularities of music to emulate the knowledge the listeners have internalised (the typical tonal profiles, intervals, rhythms). Complexity is the violation of such regularities. Using expectancy-based models, researchers were able to demonstrate that the same music may have a different complexity value for listeners with different levels of expertise or from different cultures.

We know that expertise and familiarity with the music decreases the perceived complexity, and assumes that implicit learning of the music structure will enable the listener to process the structure more effectively. This is due to chunking, segmentation and by relating the music to long-term structures – scripts and schemas in cognitive psychology. An example of this is the standard chord sequence in blues music (e.g., twelve-bar blues form), which decreases the overall complexity of the music if it is familiar to the listener.

We can distinguish perceptual complexity from performance complexity, which is dependent on technical and motor limitations, and which we know to be instrument-specific. There are proposed estimates of performance complexity based on the physical performance constraints involved in playing particular instruments (finger and motor patterns on guitar, piano, and trumpet). There has not been much attention given to this topic despite its importance to music education (for instance, assessing the difficulty levels of performance materials).

Separate elements of complexity

The conceptual base of complexity in music outlined typically utilises discrete pitches as the component of complexity. However, we can establish complexity in music on all musical parameters. We can form complexity in rhythm, with combinations of durations and transitions (rhythmic motives), or with simultaneous overlay of rhythmic patterns and syncopation. We have utilised various models of rhythm perception have to index rhythmic complexity. Hierarchical structures in music may create structural complexity, even though the individual elements and parts would be simple in isolation. A prime example of this is Johann Sebastian Bach's *Kunst der Fuge* or Steve Reich's *Clapping Music*.

In harmony, we characterise complexity in terms of number and distance of individual tones from the root in the chord or by the number and the type of harmonic changes in a sequence of chords. In both cases, the conventions of genre and the acoustic properties of the sounds contribute to the overall complexity. Typically, complex harmonic progressions are those that are far away in tonality in a circle of fifths (C to F# in a key of C). We can connect both types of complexity to an increased psycho-acoustic roughness.

Lavish instrumentation, and layered, processed sounds can also contribute to timbral complexity. There are simple indices for the richness of the spectrum (acoustic complexity) that compute the amount of change of the spectrum (e.g., spectral flux or entropy). Also changes in loudness of the signal may contribute to complexity.

We can relate complexity in terms of musical form to the number of individual sections (from a simple ternary form of AABA to a more complex chain form of ABCD), and the level of their independence and contrast. We can estimate such complexity by means of temporal self-similarity, in which we extract a given musical feature (such as tonal profile or spectral content) across the piece, after which we compute the distance between the extracted segments to every other segment. Highly complex forms have low self-similarity since there are no repeating moments.

Cultural complexity

So far, we have constrained the discussion of complexity in music to musical parameters. Complexity may also arise with respect to meanings ascribed to music by means of associations, lyrics, videos, or other cultural references. For instance, musical quotations, parody, remixes, mashups, and sound collages provide complexity by means of juxtaposed meanings and references across periods and genres. We cannot objectively assess such complexity since it is entirely dependent on the competence of the listener.

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See Also: Database studies; Computer aided musical analysis; Originality, Measures of (Simonton); Melody processing

Further readings

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